

KOKAI PATENT APPLICATION NO. HEI 10-13083

**ELECTROMAGNETIC WAVE ABSORBER**

[Translated from Japanese]

[Translation No. LPX40615]

Translation Requested by: Virginia Bergstrom 3M

Translation Provided by: Yoko and Bob Jasper  
Japanese Language Services  
16 Oakridge Drive  
White Bear Lake, MN 55110

Phone (651) 426-3017 Fax (651) 426-8483  
e-mail: jasper.jls@comcast.net

JAPANESE PATENT OFFICE (JP)

PATENT JOURNAL (A)

KOKAI PATENT APPLICATION NO. HEI 10-13083

Technical Indication Section

Int. Cl.<sup>6</sup>: H 05 K 9/00  
B 32 B 7/02  
9/00  
27/00  
27/16  
H 05 K 9/00  
B 32 B 7/02  
9/00  
27/00  
27/16  
B 32 B 27/30  
H 01 Q17/00  
B 32 B 27/30  
H 01 Q17/00

Identification Code: 104 M  
104 A  
K  
A

Sequence Nos. for Office Use: FI

Filing No.: Hei 8-167699

Filing Date: June 27, 1996

Publication Date: January 16, 1998

No. of Claims: 6 OL (Total of 5 pages in  
the [Japanese] document)

Examination Request: Not filed

# ELECTROMAGNETIC WAVE ABSORBER

*[Denjiba kyuhshuhtai]*

Inventor(s): Noriaki Ohshima  
5-21-33 Rokkakubashi  
Kanagawa-ku, Yokohama-shi  
Kanagawa-ken

[Inventors cont.] Mitsuo Endoh  
2-37-17 Ono Sagamihara  
Sagamihara-shi, Yokohama-  
shi, Kanagawa-ken

Applicant(s): 000003300  
Toso Corp.  
4560 banchi, Kaisei-cho  
Nanyo-shi, Yamaguchi-ken

*[There are no amendments to this patent.]*

## Specification

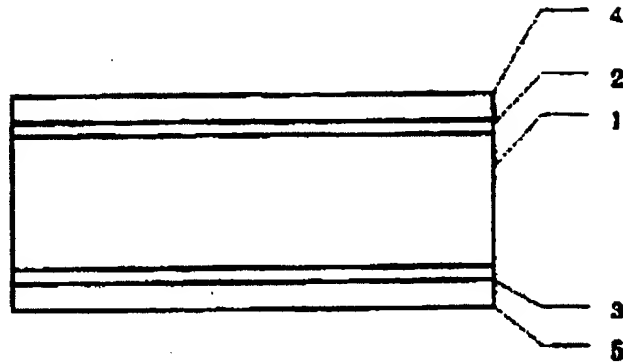
[Title of the invention]

Electromagnetic wave absorber

[Abstract]

[Problems to be solved] To provide a thin electromagnetic wave absorber with high transparency useful for EMC-EMI measures for high frequencies in the giga-hertz band.

[Means of solution] An electromagnetic wave absorber where a thin film comprised of metal oxide, metal nitride, or a mixture of same is formed on both surfaces of a dielectric layer made of a transparent organic polymer as a resistance film.



[Claims of the invention]

[Claim 1] A electromagnetic wave absorber characterized by the fact that a thin film comprised of a metal oxide, metal nitride, or mixture of same is formed on both surfaces of a dielectric layer made of a transparent organic polymer as a resistance film.

[Claim 2] The electromagnetic wave absorber described in claim 1 characterized by the fact that the dielectric layer is made of a copolymer resin composition containing a metal acrylate and/or metal methacrylate.

[Claim 3] The electromagnetic wave absorber described in claim 1 characterized by the fact that the dielectric layer is made of an acrylonitrile or methacrylonitrile polymer and a copolymer of same polled by an electric field.

[Claim 4] The electromagnetic wave absorber described in one of claims 1 to 3 characterized by the fact that the resistance film is made of either ITO (indium oxide/ tin oxide), indium oxide, tin oxide, zinc oxide or titanium nitride, and the film thickness is in the range of 0.001  $\mu\text{m}$  to 0.2  $\mu\text{m}$ .

[Claim 5] The electromagnetic wave absorber described in one of claims 1 to 4 characterized by the fact that the resistance film is formed by either ion plating method, deposition method, or sputtering method.

[Claim 6] The electromagnetic wave absorber described in one of claims 1 to 5 .

characterized by the fact that a protective film made of an organic polymer film, organic polymer sheet, or organic coated film is provided for the surface of the resistance film.

[Detailed description of the invention]

[0001]

[Technical field of the invention] The present invention pertains to an electromagnetic wave absorber useful for EMC-EMI measures for high frequency in the giga-hertz band.

[0002]

[Prior art] With the increased use of electrical waves in recent years, problems such as radio wave interference and malfunctioning of electrical and electronic equipment are surfacing. In order to eliminate the aforementioned problems, thin electromagnetic wave absorbers are used effectively. As electromagnetic wave absorbers that can be used in this case, for example, the following have been proposed: (1) an absorber produced by kneading an electrically conductive filler such as ferrite, metal, and carbon with a molding material comprising an organic polymer and dispersing the conductive filler in the polymer, (2) an absorber where an electrically conductive fiber is arranged in a lattice fashion at a specific interval, (3) an absorber where a polyethylene foam, vinyl chloride resin sheet, polymethyl methacrylate resin sheet, polycarbonate resin sheet, etc. is used as a dielectric layer and an electrically conductive layer is provided for the surface, etc.

[0003] However, in the aforementioned absorber (1), wave absorption is reduced in the short wavelength region due to state of dispersion of the filler and variation in film thickness, and furthermore, transparency cannot be imparted.

[0004] As for absorber (2), a small lattice distance is required to accommodate short wavelengths, resulting in high cost and transparency cannot be imparted.

[0005] As for absorber (3), transparency can be imparted based on high transparency of the dielectric layer, but an increase in thickness of the dielectric film is required due to the dielectric constant of the dielectric and production of a thin electromagnetic wave absorber is not possible.

[0006] As described above, a thin electromagnetic wave absorber with high transparency is not known to exist among conventional electromagnetic wave absorbers.

[0007]

[Problems to be solved by the invention] The purpose of the present invention is to eliminate the aforementioned existing problems and to produce a thin electromagnetic wave absorber with high transparency and with an absence of reduction in absorption of radio waves in the short wavelength region.

[0008]

[Means to solve the problem] As a result of much research conducted by the present inventors in an effort to eliminate the above-mentioned existing problems, the present invention was accomplished.

[0009] In the electromagnetic wave absorber of the present invention, a thin film comprising a metal oxide, metal nitride, or a mixture of same is formed on both surfaces of a dielectric layer made of a transparent organic polymer as a resistance film.

[0010] For the aforementioned dielectric layer, it is desirable when a copolymer resin composition is used containing at least one metal acrylate or metal methacrylate, or acrylonitrile or methacrylonitrile polymer or a copolymer of same polled by an electric field.

[0011] For metal acrylate or metal methacrylate used for the copolymer as a transparent organic polymer material used in the present invention, acrylates or metal methacrylates such as zinc, copper, silver, iron, nickel, cobalt, manganese, lead, aluminum, calcium, strontium, barium, gallium, yttrium, indium, lanthanum, neodymium, europium, holmium, gadolinium, ytterbium, thallium, ruthenium, vanadium, niobium, lutetium, praseodymium and erbium can be mentioned.

[0012] Furthermore, for compounds copolymerizable with the above-mentioned metal acrylate or metal methacrylate, acrylate compounds such as methyl acrylate, methacrylate compound such as methyl methacrylate, olefins such as ethylene and propylene, aromatic compounds having unsaturated bonds such as styrene, vinyl compounds such as vinyl chloride, acrylonitrile

and vinyl acetate can be mentioned.

[0013] It is possible to increase the dielectric constant of the transparent organic polymer when copolymerization is done for the metal acrylate compound or metal methacrylate compound, and as a result, a reduction in the thickness of the dielectric layer is possible.

[0014] In the above-mentioned polymer composition, the composition ratio of the metal acrylate or metal methacrylate is not especially limited, and in order to achieve a sufficient increase in dielectric constant of the copolymer resin composition and to maintain high mechanical strength and chemical stability of the copolymer resin composition, a ratio in the range of 5 wt% to 50 wt% is suitable.

[0015] Furthermore, as a compound copolymerizable with the acrylonitrile or methacrylonitrile used as a dielectric layer in the present invention, an acrylate compound such as methylacrylate or ethylacrylate, a methacrylate compound such as methylmethacrylate or ethylmethacrylate, olefins such as ethylene, propylene, and butadiene, aromatic compounds having unsaturated bonds such as styrene, vinyl compounds such as vinyl chloride, vinyl acetate, and vinyl ether can be mentioned.

[0016] When molecular orientation is controlled by an electric field and polling is done for the above-mentioned acrylonitrile polymer, methacrylonitrile polymer and a copolymer containing at least one acrylonitrile or methacrylonitrile or a mixture containing two or more of these, an increase in the dielectric constant can be achieved, and as a result, a reduction in the film thickness of the electromagnetic wave absorber having the above-mentioned polymer material as a dielectric layer can be achieved.

[0017] The resistance film formed on both surfaces of the aforementioned dielectric layer is a thin film made of a metal oxide, metal nitride, or mixture of same, and a thin film made of ITO (indium oxide/tin oxide), indium oxide, tin oxide, zinc oxide or titanium nitride is further desirable. It is desirable when the film thickness of the aforementioned resistance film is in the range of 0.001  $\mu\text{m}$  to 0.2  $\mu\text{m}$  to maintain suitable film resistance and high productivity, and in

the range of 0.002  $\mu\text{m}$  to 0.1  $\mu\text{m}$  is further desirable. For production of the aforementioned resistance film, standard thin film formation methods may be used, and, for example, the ion plating method, deposition method, and sputtering method are suitable

[0018] It is desirable when an organic protective film is formed on the surface of the resistance film provided on both surfaces of the aforementioned dielectric layer by laminating an organic polymer film or sheet or coating an organic paint to prevent deterioration in the electromagnetic wave absorber as a result of scratches formed at the time of handling of the electromagnetic wave absorber. In order to achieve adequate protection, the thickness of the protective film used in the present invention is at least 0.5  $\mu\text{m}$ , and at least 1  $\mu\text{m}$  is even more desirable.

[0019] When a copolymer resin composition containing one or more metal acrylates and metal methacrylates or acrylonitrile polymers, methacrylonitrile polymers and a copolymer containing at least one of acrylonitrile and methacrylonitrile or a mixture containing two or more of these and polled by an electric field is used as a dielectric layer and a resistance film is provided on both surfaces and an organic protective film is further laminated, a thin electromagnetic wave absorber with high transparency can be produced.

[0020]

[Working examples] The present invention is explained in further detail with the working examples below, but the present invention is not limited to these working examples.

[0021] (Working Example 1)

Methylmethacrylate containing 10 wt% of lead dimethacrylate was used to produce a sheet with a thickness of 2.8 mm.

[0022] An ITO film was applied to both surfaces of the aforementioned copolymer resin sheet to form a thickness of 280 angstroms using the sputtering method.

[0023] For protection of the resistance film, the aforementioned laminate was further laminated with a saran resin having a thickness of 80  $\mu\text{m}$  to produce an electromagnetic wave absorber.

[0024] The cross-section structure of the electromagnetic wave absorber of Working Example 1



of the present invention is shown in Fig. 1.

[0025] The laminated sheet produced as described above was set in the window of the sealed box of the measuring device shown in Fig. 2 and measurements were made to determine the frequency-absorption characteristics.

[0026] The measurement results of frequency (GHz) and transmission attenuation (dB) are shown in Fig. 3. In this case, the difference in the signal level detected by the near magnetic probe based on presence of the electromagnetic wave absorber measuring object is used for the transmission attenuation.

[0027] (Working Example 2)

Methylmethacrylate containing 10 wt% of lead dimethacrylate was used to produce a sheet with a thickness of 1.5 mm.

[0028] An ITO film was formed on the aforementioned copolymer resin sheet as in the case of Working Example 1, and for protection of the resistance film, the aforementioned laminate was further laminated with a saran resin so as to produce an electromagnetic wave absorber.

[0029] Measurements were made of the frequency-absorption characteristics of the laminated sheet produced above as in the case of Working Example 1 above.

[0030] The measurement results for frequency (GHz) and transmission attenuation (dB) are shown in Fig. 4.

[0031] (Working Example 3)

Methylmethacrylate containing 25 wt% of zinc dimethacrylate was used to produce a sheet with a thickness of 1.5 mm.

[0032] An ITO film was formed on the aforementioned copolymer resin sheet as in the case of Working Example 1, and for protection of the resistance film, the aforementioned laminate was further laminated with a saran resin so as to produce a electromagnetic wave absorber.

[0033] Measurements were made to determine the frequency-absorption characteristics of the laminated sheet produced above as in the case of the aforementioned Working Example 1.

[0034] The measurement results of the frequency (GHz) and transmission attenuation (dB) are shown in Fig. 5.

[0035] (Working Example 4)

An acrylonitrile-styrene copolymer having a copolymerization composition ratio of 40/60 was molded into a sheet with a thickness of 2.8 mm, the aforementioned molding was placed between electrode sheets and a polling treatment was provided as 300 V electric field was applied while heating at 120°C and subsequently cooling slowly.

[0036] An ITO film was formed on the aforementioned copolymer resin sheet as in the case of Working Example 1, and for protection of the resistance film, the aforementioned laminate was further laminated with a saran resin so as to produce an electromagnetic wave absorber.

[0037] Measurements were made to determine the frequency-absorption characteristics of the laminated sheet produced above as in the case of Working Example 1 above.

[0038] The measurement results of the frequency (GHz) and transmission attenuation (dB) are shown in Fig. 6.

[0039] (Working Example 5)

An acrylonitrile copolymer was molded into a sheet with a thickness of 1.5 mm, the aforementioned molding was placed between electrode sheets and a polling treatment was done as 300 V electric field was applied while heating at 110°C and subsequently cooling slowly.

[0040] An ITO film was formed on the aforementioned copolymer resin sheet as in the case of Working Example 1, and for protection of the resistance film, the aforementioned laminate was further laminated with a saran resin to produce an electromagnetic wave absorber.

[0041] Measurements were made for the frequency-absorption characteristics of the laminated sheet produced above as in the case of Working Example 1 above.

[0042] The measurement results of the frequency (GHz) and transmission attenuation (dB) are shown in Fig. 7.

[0043] (Working Example 6)

An methacrylonitrile-styrene copolymer having a copolymerization composition ratio of 65/35 was molded into a sheet with a thickness of 2.8 mm, the aforementioned molding was placed between electrode sheets and a polling treatment was provided as 300 V electric field was applied while heating to 130°C and subsequently cooling slowly.

[0044] An ITO film was formed on the aforementioned copolymer resin sheet as in the case of Working Example 1, and for protection of the resistance film, the aforementioned laminate was further laminated with a saran resin to produce an electromagnetic wave absorber.

[0045] Measurements were made for the frequency-absorption characteristics of the laminated sheet produced above as in the case of Working Example 1 above.

[0046] The measurement results of the frequency (GHz) and transmission attenuation (dB) are shown in Fig. 8.

[0047]

[Effect of the invention]

As explained in detail above, when an organic polymer with high dielectric constant containing at least one metal acrylate or metal methacrylate or a copolymer containing an acrylonitrile or methacrylonitrile polymer and/or one or more of these, polled by an electric field, is used as a dielectric layer and a resistance film is laminated on both surfaces of said layer, a thinner electromagnetic wave absorber with higher transparency than those of electromagnetic wave absorbers of the prior art can be produced.

[Explanation of Figures]

[Fig. 1] A cross-section structure of the electromagnetic wave absorber of the present invention.

[Fig. 2] A measuring device for electromagnetic wave absorber characteristics used in the Working Examples.

[Fig. 3] Measurement results of frequency (GHz) and transmission attenuation (dB) of Working Example 1 of the present invention.

[Fig. 4] Measurement results of frequency (GHz) and transmission attenuation (dB) of Working Example 2 of the present invention.

[Fig. 5] Measurement results of frequency (GHz) and transmission attenuation (dB) of Working Example 3 of the present invention.

[Fig. 6] Measurement results of frequency (GHz) and transmission attenuation (dB) of Working Example 4 of the present invention.

[Fig. 7] Measurement results of frequency (GHz) and transmission attenuation (dB) of Working Example 5 of the present invention.

[Fig. 8] Measurement results of frequency (GHz) and transmission attenuation (dB) of Working Example 6 of the present invention.

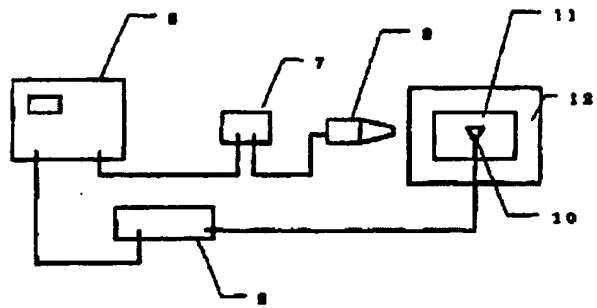
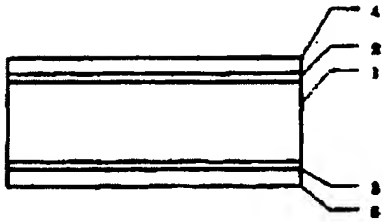
[Explanation of codes]

- 1 ... Dielectric layer
- 2, 3 ... Resistance film
- 4, 5 ... Organic protective film
- 6 ... Spectrum analyzer
- 7 ... Amplifier
- 8 ... Near magnetic field probe
- 9 ... Tracking generator
- 10 ... Magnetic field generating source antenna
- 11 ... Electromagnetic wave absorber measuring object
- 12 ... Sealed box

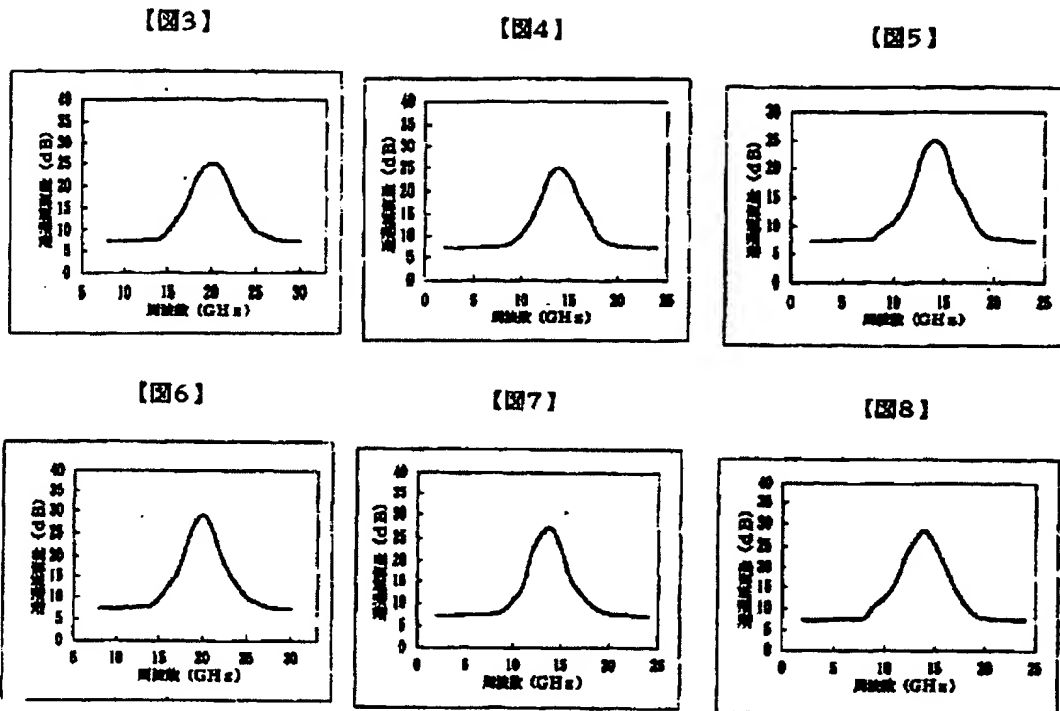
[Fig. 1]

[Fig. 2]

Translation of KOKAI PATENT APPLICATION NO. HEI 10-13083



[Fig. 3] through [Fig. 8]



Vertical axis: transmission attenuation (dB)

Horizontal axis: frequency (GHz)

//Continued from first page//